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Indian Standard

SPECIFICATION FOR DIRECT READING POINTER INDICATOR TYPE AC ELECTRONIC MILLIVOLTMETER

PART I METHODS OF MEASUREMENTS

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May 1973

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SPECIFICATION FOR DIRECT READING POINTER INDICATOR TYPE AC ELECTRONIC MILLIVOLTMETER

PART I METHODS OF MEASUREMENTS

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(*Continued on page* 2)

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Indian Standard

SPECIFICATION FOR DIRECT READING POINTER INDICATOR TYPE AC ELECTRONIC MILLIVOLTMETER

PART I METHODS OF MEASUREMENTS

0. FOREWORD

0.1 This Indian Standard (Part I) was adopted by the Indian Standards Institution on 7 December 1972, after the draft finalized by the Electronic Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard (Part I) covers methods of measurements of characteristics of ac electronic millivoltmeters of direct reading pointer indicator type operating over a frequency range of 2 Hz to 5 MHz. The electronic voltmeters, covered by this standard generally are of the amplifier-rectifier type.

0.2.1 This standard applies to complete apparatus only and not to the component parts thereof.

0.2.2 This standard does not cover digital type electronic voltmeter.

0.3 This standard is one of a series of Indian Standards on electronic measuring equipment.

0.4 This standard lays down a single method of measurement for each characteristic so as to achieve the required degree of accuracy. It is not however intended to exclude other alternative methods of measurement for which necessary measuring equipment may be available and which are of equal or greater accuracy than the method prescribed in this standard.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard (Part I) prescribes the conditions and detailed procedures for the measurement of performance characteristics of direct reading pointer indicator type electronic millivoltmeter operating over a frequency range of 2 Hz to 5 MHz.

2. TERMINOLOGY

2.0 For the purpose of this standard the definitions and explanations of terms specified in 2 of IS : 3437-1972* shall apply.

3. GENERAL CONDITIONS FOR MEASUREMENTS

3.0 Unless otherwise specified, measurements shall be made under normal measuring conditions as specified in **3.1** to **3.5**.

3.1 Normal Supply Voltage — Rated supply voltage shall be applied to the electron millivoltmeter.

3.1.1 The voltage applied to the millivoltmeter shall be held constant within 1·0 percent of the rated value during the measurements of the characteristics.

3.1.2 In case of ac mains operation, the voltage shall be applied at the rated frequency. The harmonic content of ac mains supply voltage shall not exceed 5·0 percent.

3.1.3 In case of battery operation, primary or secondary batteries of the type and rated voltage as specified by the manufacturer, shall be used.

3.2 Standard Atmospheric Conditions for Tests

3.2.1 Unless otherwise specified, all tests shall be carried out under the following atmospheric conditions:

Temperature	Between 15 and 35°C
Relative humidity	Between 45 and 75 percent
Atmospheric pressure	Between 860 and 1 060 mbar

3.2.1.1 Where the conditions mentioned above have a significant influence, these shall be kept substantially constant during the test.

3.2.2 For specific tests which are considered dependent on atmospheric conditions, the tests shall be conducted, and in case of doubt, the tests shall be repeated at temperature of 27 ± 1°C and relative humidity of 65 ± 2 percent (*see* IS : 196-1966†).

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*General requirements for direct reading pointer indicator type electronic voltmeter (*first revision*).

†Atmospheric conditions for testing (*revised*).

3.2.3 The instrument shall be protected from draughts and direct radiations.

3.3 Measurements

3.3.1 All the measurements shall be made under the conditions mentioned in each clause.

3.3.2 *Preliminary Adjustments* — The index of the voltmeter having a mechanical zero shall be set to the appropriate mark on its scale. The rated supply voltage shall then be applied for a time equal to the warm-up time as specified by the manufacturer; in the absence of such information, this voltage shall be applied for a period of 15 minutes. All the other preliminary adjustments specified by the manufacturer shall be carried out. In making measurements, the mechanical zero shall not be altered.

3.3.3 Unless otherwise specified in the relevant clauses, all measurements shall be carried out within the measuring range.

3.4 Accuracy of Test Set-Up — The test set-up employed to carry out the measurements in accordance with this standard shall have an accuracy of at least one order better than that specified for the quantity under measurement.

3.5 Reporting — The test report shall clearly indicate the following:

a) Rated supply voltage and frequency in case of ac,

b) Atmospheric conditions under which tests are carried out, and

c) Accuracy of test instruments.

4. ACCURACY

4.1 Accuracy of Voltage Range

4.1.1 The accuracy of the different voltage ranges of the instrument shall be measured at least at three points, say, at 10 percent, 50 percent and 100 percent of the effective range on each voltage range at 1 kHz using the set-up given in Fig. 1.

NOTE 1 — The output impedance of the attenuator shall be at least three order (that is 1 000 times) lower than the impedance of the millivoltmeter under test.

NOTE 2 — The low frequency attenuator shall be matched to the signal generator and shall be suitably terminated, if necessary, at its output side.

NOTE 3 — Preferably a true rms indicator should be used.

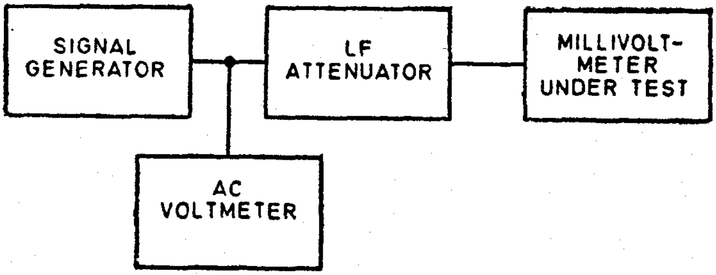


FIG. 1 SET-UP FOR CALIBRATION OF VOLTAGE RANGES

4.1.2 A sinusoidal voltage at a frequency of 1 kHz (obtained from a signal generator) shall be fed to the millivoltmeter under test through an attenuator (*see* Note 1 under **4.1.1**) as shown in Fig. 1. The source and the attenuator levels shall be adjusted suitably till the desired deflection in the particular range (*see* **4.1.1**) is obtained. The settings of the attenuator shall be noted. The amplitude of the input voltage to the attenuator shall be measured with an ac voltmeter (*see* Note 2 under **4.1.1**). Necessary corrections for the wave form distortion of the input signal may be made.

4.1.3 From these measurements, the accuracy of the voltage range shall be computed.

5. VARIATION IN INDICATION

5.1 Fluctuations — After the preliminary adjustments, a voltage corresponding to a steady deflection equal to 70 percent of the effective range shall be applied between the input terminals. The fluctuations of the index (pointer) (the random and spurious deviations) shall be observed during one minute period over a specified interval. This shall be at least 15 minutes for ranges of 1 V or less, or one hour for other ranges. The maximum fluctuations occurring over a one minute period shall be noted.

5.1.1 The fluctuations shall be measured for each range.

5.2 Drift — After preliminary adjustments, a voltage corresponding to a steady deflection equal to 70 percent of the effective range shall be applied between the input terminals. The maximum deviation of the index (pointer) from the nominal value shall be observed during the time interval specified by the manufacturer. This shall be at least 15 minutes for ranges of 1 V or less or one hour for other ranges. Maximum value of the drift shall be noted.

5.2.1 The drift shall be measured for each range.

5.3 Influence of Supply Voltage Change

5.3.1 With no input voltage applied, the voltmeter shall be energized for a time (after warm-up period) sufficient to ensure that the drift is negligible compared with the permitted variation of the index (pointer) consequent upon the change of supply voltage. An input voltage equal to 90 percent of the upper limit of the effective range shall then be applied between the input terminals. A sudden and sustained change of 5 percent (positive or negative) is made in the supply voltage. During a period of one minute immediately following this change, the maximum value of variation in indication shall be noted.

5.3.2 The test shall be continued with a second step of 5 percent sudden and sustained change in the supply voltage superimposed on the first one in the same direction, for a further period to bring the total time of both variations to 15 minutes or the warm-up time if longer. The final variation in indication shall be determined. The limits of permissible variation in indication shall be expressed as percentage of the scale length.

5.3.3 The measurement shall be carried out on each range and for both positive voltage change and for negative voltage change.

5.4 Influence of Super-Imposed Voltage

5.4.1 *For Voltmeter Sensitive to Alternating Voltage Ranges* — After preliminary adjustments, a voltage corresponding to a steady deflection equal to 70 percent of the effective range shall be applied between the input terminals. A direct voltage which is 1 000 times the rating of the range under test, this value being limited to the specified insulation voltage, shall be applied across the input terminals of the voltmeter. Deviation of the index after removal of the voltage shall be noted, from which the deviation of index due to super-imposed dc voltage shall be computed. This test shall be carried out on each range of the voltmeters.

NOTE — A voltmeter containing a transformer or a semiconductor device connected to its input terminals shall not be tested with super-imposed dc voltages.

5.5 Influence of Position — The influence of the position shall be determined for one of the ratings only. After the preliminary adjustments, a voltage corresponding to a steady deflection equal to 70 percent of the effective range shall be applied between the input terminals. With the voltmeter in reference conditions and also with the voltmeter inclined to its reference position by an angle of ± 5° in two perpendicular planes successively, the reading of the index shall be noted. When several reference positions are indicated, the voltmeter shall be tested in each of these positions. When no reference position is indicated, measurements shall be made with the voltmeter in the normal operating position and also in a position perpendicular to this operating position.

5.5.1 From these measurements the variation in indication shall be computed.

5.6 Influence of Ambient Temperature Change

5.6.1 The influence of ambient temperature on the indications of the voltmeter shall be determined from measurements made at intervals of 10 ± 1°C within the nominal range. When no nominal range of use concerning the ambient temperature is indicated by the manufacturer, this range shall be between two limits respectively equal to 10°C above and 10°C below the reference temperature.

5.6.2 After the preliminary adjustments, a voltage corresponding to a steady deflection equal to 70 percent of the effective range shall be applied between the input terminals, the voltmeter being under reference conditions. The temperature shall be varied in steps of 10°C and the variation in indication shall be measured at each step after thermal equilibrium is reached at that temperature. When these measurements are made, the total deviation over the specified temperature range shall be computed.

6. INPUT IMPEDANCE

6.1 AC Input Impedance — The input impedance shall be measured at the specified frequency of 100 kHz with the instrument switched on. The input impedance shall be expressed in term of its equivalent parallel resistive and reactive components. The measurements may be made with a Q-meter.

6.1.1 The Q-meter shall be tuned for resonance at a frequency of 100 kHz with a suitable inductance and the magnification factor (Q_1) and capacitance (C_1) shall be noted. The input terminals of the millivoltmeter shall be connected to the capacitance terminals of the Q-meter which is returned for resonance at the same frequency of 100 kHz. The magnification factor (Q_2) and the capacitance (C_2) shall be noted. The input capacitance and resistance of millivoltmeter are given by:

a) Input capacitance $= C_1 - C_2$

b) Input resistance $= \dfrac{Q_1 \times Q_2}{2\pi f C_1 (Q_1 - Q_2)}$

where f is resonance frequency.

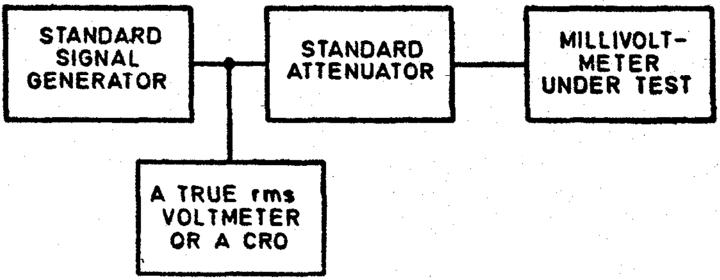
NOTE — Correction for self-capacitance of inductance shall be applied.

6.1.2 The input impedance shall be measured at 1 kHz also.

NOTE — A suitable impedance bridge may be used for measurement at this frequency.

7. FREQUENCY CHARACTERISTICS

7.1 Frequency Response — The frequency response measurement shall be carried out with the set-up given in Fig. 2. The input to the millivoltmeter shall be kept constant for a reasonable deflection, say 70 percent of the full scale deflection at the lowest range (that is the most sensitive range). The frequency of the signal generator shall be varied over the specified range of frequency and corresponding reading on the millivoltmeter shall be taken. The response, namely deflection *versus* frequency over the specified frequency range, shall be obtained with respect to value at 1 kHz.


STANDARD SIGNAL GENERATOR
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MILLIVOLT-METER UNDER TEST
A TRUE rms VOLTMETER OR A CRO

FIG. 2 SET-UP FOR FREQUENCY RESPONSE MEASUREMENT

8. SWINGING

8.1 This measurement shall be done at the lowest sensitivity range. Voltage at a frequency close to the supply frequency shall be applied across the input terminals and adjusted to such a value that the pointer reaches 90 percent of the upper limit of the effective range. The frequency of the input signal shall then be varied keeping the input constant until the amplitude of the swinging, if any, reaches a maximum value. The total amplitude of the swinging shall be expressed as a percentage of the scale length. The measurement shall be repeated at low multiples of the supply frequency.

8.1.1 The maximum swinging and the frequency at which it occurs shall be noted.

9. DAMPING

9.1 The damping of a voltmeter is determined by the measurement of the overshoot and settling time. After preliminary adjustments, a low frequency ac voltage corresponding to a steady deflection equal to 70 percent of the upper limit of the effective range shall then be suddenly applied between the input terminals. Under these conditions, the overshoot shall not exceed the upper limit of the effective range. The time required for the index to attain its final steady position, within 1·5 percent of the upper limit of the effective range, shall be measured.

10. ERRORS DUE TO OVERLOAD

10.1 Continuous Overload — An input voltage of 1·2 times the maximum value of each range shall be applied for two hours, at the end of which, the voltmeter shall be checked for the requirements of its specified accuracy.

10.2 Overloads of Short Duration — An input voltage of the following values shall be applied 5 times, the application time for each overload being one second and the time interval between two successive overloads being 15 seconds:

Up to 10 V	5 times the rating
Up to 100 V	3 times the rating
Up to 300 V	2 times the rating
Up to 30 kV	1·5 times the rating

10.2.1 At the end of this test and after a specified recovery time, the voltmeter shall be checked for the requirements of its specified accuracy.

11. INFLUENCE OF EXTERNAL MAGNETIC FIELD

11.1 The voltmeter shall be placed in the centre of a circular coil of one metre mean diameter, of square section and of radial thickness small compared with the diameter.

11.1.1 The total current in the test coil shall be so chosen that in the absence of the voltmeter under test, a magnetic field is produced, the induction of which has a value as specified by the manufacturer or 0·5 millitesla when not specified by the manufacturer.

11.1.2 Voltmeters having any maximum external dimension exceeding 25 cm shall be tested in a coil of mean diameter not less than four times the maximum dimension of the voltmeter and the current shall be so chosen as to obtain in the centre of the coil a magnetic field, the induction of which is as specified above.

11.1.3 For all voltmeters, a test shall be carried out with a magnetic field produced by a direct current. An additional test shall be made with a magnetic field produced by an alternating current for the types of voltmeters specified below having a frequency given thereon:

Type of Voltmeter	*Test Frequency*
Voltmeter with ac supply	Frequency of supply voltage
Voltmeter with dc supply	Any frequency between 40 and 65 Hz
Voltmeter measuring alternating voltages with an upper limit of frequency lower or equal to 1 kHz	Any one frequency within the nominal range of use of the frequency of the measured voltage
Voltmeter measuring alternating voltages with an upper limit of frequency higher than 1 kHz	1 kHz

Under these conditions and under the most unfavourable conditions of direction of induction, variation in indication shall be measured.

12. INFLUENCE OF EXTERNAL ELECTRIC FIELD — Under consideration.

13. INFLUENCE OF EXTERNAL RF ELECTROMAGNETIC FIELD — Under consideration.

(*Continued from page* 2)

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INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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